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Analysis of an e-learning platform use by means of the axiomatic design

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Abstract

The Moodle platform was proposed and initially developed by Martin Dougiamas and it aimed at supporting professors in generating documents publishable on line, so that the didactic process is improved by a more intense interaction and collaborative design of the educational curriculum. The use of Moodle platforms has known a continuous development and it is expected that the platform and the use of the platform would be developed and improved in the future. Elaboration and use of the Moodle platform correspond to a design process and this means that it could be analyzed including by means of the axiomatic design principles. In the paper, the customers' needs were taken into consideration, the functional requirements were formulated and the design parameters specific to the use of the Moodle platform were determined, in the context of the didactic activities deployed in a technical university. The analysis of the way in which the content of Moodle platform is used by means of the axiomatic design tools could facilitate a clearer definition of the customer needs and more adequate inclusions of documents and tools on the platform content, in order to satisfy the customers' needs. The analysis highlights some directions in order to improve the efficiency of the use of the Moodle platform.

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Keywords: Moodle platform; analysis; axiomatic design; technical university.

1. Introduction

According to an accepted definition [1], *the educational process* could be regarded as a learning process "in which the knowledge, skills, values, beliefs and habits of a group of people are transferred from one generation to the next through storytelling, discussion, teaching, training and or research".

As mentioned above, there are various ways that can be applied in order to materialize the educational process. The persons involved in the educational process and especially the researchers have always searched for solutions in order to improve the quality and the efficiency of the educational process. The current situation of informatics and information technology offers new methods and tools applicable when the issue of improving the educational process is approached. Among these methods and tools, nowadays, *the e-learning platforms* are relatively frequently used in various stages of institutional educational processes; the e-learning includes all the educational situations where the means of communication and information technology are significantly applied. One of the e-learning applications is based on the use of a network made up of server and computers.

There has been an interest of the researchers and specialists in information and communication technology in designing, developing and applying a software platform to improve the educational process. Over the last decades, adequate software was designed and developed in order to be used within the educational process. Some software is free and has open access, while other software is available against a fee. One may consider that e-learning has lead to a genuine revolution of the educational process; even though e-learning was initially applied only in the classical educational process, nowadays the corporations are also interested in using e-learning in their training processes.

Nomenclature

FR	functional requirement
DP	design parameter
PV	processvariable

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Pappas [2] appreciates that the e-learning could diminish the instruction time by up to 60% and save business at least 50% when the classical instructor-based training is replaced by e-learning. At the same time, he considered that by 2013 46% of the college students would take at least one course online and by 2019 about 50% of all college class activities would be based on e-learning. If in 2011 the e-learning industry meant $35.6 billion, in 2013 the expenses increased to $56.2 billion and it is expected to be double in 2015.

Anaraki developed a research concerning the efficiency increase of the use of e-learning platforms [3]. He showed that such platforms need more interaction between the student and the learning management system, in order to analyze the students' opinions and generate adequate responses to their problems.

It is normal for many e-learning platforms to be used in academic activities (table 1). One can mention that in fact some of the most used e-learning platforms are the following: Moodle, Blackboard, Kenexa, digitalCHALK, Sakai, Brightspace, Acatar, Canvas, +CMS, Atutor, Claroline, Dokeos, Drupal, Ilias etc.

Table 1.Some features of available e-learning platforms (after [4, 5, 6, 9])

No.	e-learning platform	Ease of content generation	Ease of use	Cost/pricing
1	Moodle	4.5	Hard	Free
2	Blackboard	4	Medium	Custom/Pricey
3	Kenexa	3.5	Medium	Custom/Pricey
4	digitalCHALK	3	Medium	$399-$1095
5	efront	2.5	Hard	Monthly $85-1200
6	Sakai			Free
7	Brightspace (D2L – Desire2Learn)	?	Easy	$10.20 enterprise cost per user
8	Acatar		Medium	?
9	Canvas	4	Easy	$4.82 hosted cost per user

Various criteria were used in evaluating the e-learning platforms. Thus, in [4], the following evaluation criteria are proposed: cost, ease of use, maturity and presence, appearance (look and feel), ability to integrate with existing student information system, suite of supports, special feature (applications, filtering systems etc.). As evaluation criteria, Saed [5] took into consideration: security, performances, support, interoperability, ease of use, management, communication tools, administration tools, course delivery tools, content development. The authors of the reviews included in [6] appreciated that the following criteria are essential in selecting a certain e-learning platform: ease of use, ease of content creation, student engagement and cost/pricing. As evaluation criteria, Graf and List preferred [7] to use the communication tools, learning objects, management of user data, usability, adaptation, technical aspects, administration, and course management. In order to develop an Al Ajlan [8] classified the e-learning features and capabilities into three categories: learning tools, support tools and technical tools.

Some features of the e-learning platforms presented in the specialty literature are mentioned in table 1.

As a result of their studies concerning the evaluation of the e-learning platforms developed for academic institutions, most researchers appreciated that the Moodle platform could be considered best adapted to the requests specific to such institutions.

A statistical analysis of the use of e-learning platforms, tools and software for academic institutions [9] showed that the first five platforms are *Moodle, Blackboard, Kenexa, digitalchalk* and *efront*. As criteria for the appreciation, the ease of use, ease of content creation, student engagement, and cost/pricing were considered.

Essentially, the Moodle is appreciated as free and open learning software. It was the result of the activities developed beginning with 1986 by the Australian educator and computer scientist Martin Dougiamas; the name Moodle is the abbreviation of the concept Modular Object-Oriented Dynamic Learning Environment.

The first version of Moodle was released on 20th August 2002 and it was originally dedicated to the university environment. The Moodle platform is believed to be applied in more than 225 countries and more than 65 million persons use this platform [10]; only in U.S.A, in 2013, there were over 14,000 registered sites using the Moodle platform.

It is interesting to emphasize that the Moodle platform is used nowadays not only in the academic environment, but also in primary and secondary schools, in the business field or in public administration. The essential principles applied in the design of the Moodle platform were those specific to *the constructivist direction of learning*, which means that the people would learn best by involvement and experiences [11]. Distinct classes of users are considered, and distinct access levels and permissions are available to each class.

The main arguments discussed in order to explain the large expansion of the Moodle platform take into consideration the ease of use, the fact that it is an open source, that it is available in more than 70 languages and that there is a vast and active community of users willing to offer assistance and advice to those who want to use this platform.

As mentioned above, the main advantage of the Moodle platform could result from its ease to use, ease of content generation, student involvement, lack of a license acquisition cost.

The issue of using the axiomatic design in the educational process was investigated by Thompson et al. [12]. They showed that the axiomatic design seems to be a useful tool in designing the educational curricula. One of their conclusions was that the axiomatic design could contribute to a better design of the educational process and decrease of the risks of high costs involved by the use of trial and error method.

Thompson and Beunguk [13] also analyzed the way in which an online grading system could be developed in the case of a first year project-based design course. They took into consideration some advantages of such a system over analogous grading methods, namely scalability, real-time

feedback on the status of grading, diminished potential for human error in compiling grades etc.

Towner developed a vast research concerning the possibilities to design the engineering education as a manufacturing system [14]. He appreciated that in order to diminish the educational costs and to improve the engineers' training, the engineering education could be designed or re-designed using the principles valid in manufacturing and industrial engineering axiomatic design, computer simulation and financial analysis.

In a paper, in which the issue of using the axiomatic design in order to approach the manufacturing engineering as a science was approached [15], Brown concluded that two functional requirements could be considered as base axioms for manufacturing science; he considered that these two axioms could involve minimizing the value added and minimizing the cost.

Büyüközkan et al. proposed [16] the use of an approach based on axiomatic design in the process of evaluating the quality of e-learning sites for fuzzy group decision making. The validation of the results was achieved by means of fuzzy TOPSIS multi-criteria decision making technique.

When the authors of this paper took into consideration the possibility of applying the axiomatic design in analyzing the use of the Moodle platform in the educational activities developed in a technical university, there was the opinion that the problem would not be too difficult, but taking into consideration the variety and the complexity of the opinions expressed by the researchers and the users of the Moodle platform or of other e-learning platforms, one consented that a continuous and deeper research could be developed in order to make clear the opportunities of applying principles of axiomatic design in analyzing the use of the Moodle platform and the opportunities to better apply this platform in the educational process.

The objective of the research presented in this paper was to initiate an analysis of the use of the Moodle platform taking into consideration some of the tools offered by the axiomatic design.

2. Customer needs in case of Moodle platform analysis by means of the axiomatic design

As a direct customer in the use of Moodle platform, the student could be taken into consideration, but an equally important customer is the teacher. The human society may also be analyzed as an end customer. If the educational process is discussed, the society wants the university to provide well trained specialists/engineers for each of its areas of interest. One may also analyze the role of the employer as a possible customer; in fact, as Thompson showed [17], a deeper analysis for defining the customer, the client and the user could be considered.

One can also take into consideration the fact that in designing the first version of Moodle platform, M. Dougiamas considered among the objectives the generation of a system for management of teaching or/and learning process; these aspects could also be appreciated as more detailed customer needs.

If one analyzes the customer needs at the levels of teacher and student, one can notice that whereas the professor needs tools to improve the efficiency of the teaching process, the student's main need refers to the ease of learning or, more properly, of accumulating knowledge and developing skills and competences. One appreciates that these were the customer needs in designing the Moodle platform, even if the objectives of the activity developed by M. Dougiamas were otherwise formulated.

A more detailed analysis of the customer needs could emphasize more proper aspects of the educational process, since one can notice that other aspects of the customer needs have not been taken or could not be taken into consideration in designing the Moodle platform. For example, there is no possibility of a direct face-to-face professor and student interaction and the utility of this presence could be the object of a separate discussion and ample analysis.

3. Functional requirements and design parameters specific to the Moodle platform design

In accordance with the customer needs, the *functional requirement (FR)* of zero level could be:

FR0: Generate tools for improving the educational process/making the educational process more efficient.

One noticed that when approaching in detail the second level functional requirements, many versions are possible and many opinions were expressed by the specialists involved in the use or developing the Moodle platform. One adopted a relatively simple and generally valuable version, in order to cover the diversity of opinions found in the literature or in the discussions with various specialists.

Thus, as main second level functional requirements, one may consider [6, 10]:

FR1: Manage the information on overall. Basically, the platform should ensure opportunities to save and access information specific to the university educational process;

FR2: Organize the activity. Moodle could contain elements of booking classrooms, schedules, calendars, planning meetings and activities (applicative activities, evaluation tests, homework etc.);

FR3: Provide opportunities for communication and collaboration between students and teachers. Tools such as courses, homework, forums and chats facilitate the communication among the categories of users involved in the educational process;

FR4: Provide opportunities for team work. The users can generate, edit and use distinct documents, test ideas, organize debates;

FR5: Provide opportunities for students' assessment and self-assessment.

When analyzing some details of the Moodle platform use, one may notice that the functional requirements of second order could be:

FR1.1: Provide the general structure of the documents and activities to be uploaded on the platform;

FR1.2: Set the capabilities susceptible to be allocated in future for storing and processing information;

Table 2. Matrix that includes functional requirements and design parameters established in the case of analysing the use of Moodle platform

Line no.			DP	Design parameters															
1	FR																		
2				DP of first level															
3				DP1		DP2			DP3					DP4				DP5	
4				DP of second level															
5				DP 1.1	DP 1.2	DP 2.1	DP 2.2	DP 2.3	DP 3.1	DP 3.2	DP 3.3	DP 3.4	DP 3.5	DP 4.1	DP 4.2	DP 4.3	DP 4.4	DP 5.1	DP 5.2
6 Column no. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
7	Functional requirements			Highlighting design parameters corresponding to each functional requirement															
	FR of zero level	FR of first level	FR of second level																
8	FR0	FR1	FR1.1	X															
9			FR1.2		X														
10		FR2	FR2.1			X													
11			FR2.2				X												
12			FR2.3					X											
13		FR3	FR3.1						X										
14			FR3.2							X									
15			FR3.3								X								
16			FR3.4									X							
17			FR3.5										X						
18		FR4	FR4.1											X					
19			FR4.2												X				
20			FR4.3													X			
21			FR4.4														X		
22		FR5	FR5.1															X	
23			FR5.2																X

FR2.1: Organize booking the classrooms for courses and seminars;

FR2.2: Organize development in time of the didactic activities;

FR2.3: Plan meetings and other activities;

FR3.1: Manage the course (request for introducing a course, introducing the course and course settings, introducing functions and menus for course management, manage the course activities etc.);

FR3.2: Manage the seminars;

F3.3: Manage the homework;

F3.4: Manage the applicative activities;

F3.5: Manage the technological practice;

FR4.1: Manage the operation of forums;

FR4.2: Manage the operation of chats;

FR4.3: Manage the operation of debates;

FR4.4: Manage receiving and approaching proposals;

FR5.1: Manage the tests for students' self-assessment;

FR5.2: Manage the tests for students' assessments by teachers.

For each of the above mentioned functional requirements, adequate *design parameters (DP)* must be found and elaborated. In most cases, this means ensuring versions to fulfill the functional requests. This could imply, for example:

DP1: General structure and memory resources set;

DP1.1: General structure of materials to be uploaded set;

DP1.2: Memory resources allocated;

DP2: Activities planned

DP2.1: Classrooms for courses and seminars booked;

DP2.2: Schedules;

DP2.3: Meetings and other activities planned;

DP3: Tools set for communication and collaboration between students and teachers

DP3.1: Courses;

DP3.2: Seminars structure and development;

DP3.3: Structure set for homework;

DP3.4: Structure for applicative (laboratory) activities and their development;

DP3.5: Structure for technological practice;

DP.4: Tools set for team work

DP4.1: Structure set for forums;
DP4.2: Structure set for chats;
DP4.3: Structure set for debates;
DP4.4: Structure set for proposals;
DP5: Tools set for students' assessment and self-assessment
DP5.1: Tests for students' self-assessment;
DP5.2: Tests for students' assessment by teachers.

For *DPs*, in some cases, as metrics one can take into consideration a certain succession of subjects/ questions/ recommendations to be developed by the student in his homework, for example, or during seminars or debates. The number of these subjects/questions/recommendations and their contents offer an image about the *DPs* metrics.

The *process variables (PV)* could take into consideration the proper structure, characteristics and volume of each design parameter.

Based on the above mentioned functional requirements and design parameters, one can elaborate the corresponding general matrix. One appreciates that the matrix including the functional requirements and design parameters proposed to model the use of the Moodle platform by means of the axiomatic design can be considered as an uncoupled matrix. The character or uncoupled matrix corresponding to this matrix is regarded as the result of a continuous process of e-learning platform improvement developed over the years. Even in their initial activity of the platform, designers did not consider the principles valid in the case of axiomatic design, the axiom of independence of functional requirements being applied precisely in order to ensure possibilities of developing various and independent activities by means of the platform. Relationships corresponding to an uncoupled design could also be written for each first order functional requirement.

However, in a detailed analysis, one may notice that it is possible to observe deviations from the axioms of independence of functional requirements. For example, one can notice that the contents of seminars, homework, applicative activities etc. have to be elaborated in a certain correlation among them and with the course content, if a specific subject matter is considered.

4. Experience in using the Moodle platform

Within the "Gheorghe Asachi" Technical University of Iaşi, at the management level, there have been constant preoccupations to improve the educational process, in order to make this higher education technical institution from Iaşi more competitive and attractive. Thus, the information and communication technologies have been gradually introduced being nowadays available to professors and students alike.

The Moodle platform was implemented in several of the eleven faculties of the university, starting with the faculties of electrical profile. As a difference in comparison with other universities, where a common platform was created at the level of the entire institution, here each faculty adopted its own procedure considering its specific preferences, since a unitary vision did not ensure a more efficient cooperation in identifying the best solutions for a large range of problems. When the problem of adopting an e-learning platform was discussed, various reasons determined the orientation to the Moodle platform, as mentioned above, this being in fact the most frequently used e-learning platform in the academic field.

One may notice that nowadays the use of the Moodle platform at the "Gheorghe Asachi" Technical University does not have the high efficiency seen in the universities found in developed states, this situation being allegedly generated by several reasons. In the opinion of the authors of this paper, some of these reasons could be:

- There has not been a systematic information, debate, coordination and adequate training of all the professors regarding the possibilities offered by the Moodle platform. One may assess that simple demo sessions are not enough to provide adequate training to professors as well as an increase of the interest in promoting and applying e-learning tools by means of the Moodle platform. ;
- There are many professors who do not possess the necessary skills and knowledge to use the tools offered by the Moodle platform and who thus prefer the use of the traditional work methods in lectures, seminars, applicative activities etc. Only relatively few professors have genuinely agreed to invest time and energy in hard work in order to develop an online course and to completely use the facilities provided by the Moodle platform;
- Despite the great potential of the Moodle platform, it is often/mainly used only as a repository for course materials and resources (text documents, Power Point files, videos, links to other web pages, flash animations etc.), the other functionalities/options of the platform such as synchronous and asynchronous online communication (respectively chat and forum discussions), assessment tools (quizzes, online tests and surveys) being less frequently used;
- The university does not have long-distance learning programs, which could offer additional arguments in order to introduce and use modern educational tools specific to this type of education. This situation has led to the use of the platform resources only as an extension or an addition to the classroom lectures. The professors have limited the platform application only to offer the students the additional materials able to help them in a better and easier understanding of the concepts presented during lectures. On the other hand, many students also have jobs, and this does not allow them to take part in all lectures and, for these students, the lecture notes and all support material uploaded on the Moodle platform really help them learn for the test specific to the continuous assessment and the final exams;
- The students have internet connections and information technology devices/computers, within students residences, faculties or at their houses and, in this way, the base premise of using the Moodle platform is fulfilled, but a rather strong competition between the Moodle platform and other communication and collaboration platforms or services (Facebook, Google Groups, Yahoo Groups) occurs.

One may regard that the role of the student/learner gives students enough freedom and facilitates the access to the modules/sessions of training or assessment. An interesting situation appeared in didactic activities developed by some of the authors of this paper in the master program concerning *the car design and design management.*

As part of the applicative activities, the students had to work in organized teams in order to develop a certain project. Even if the students attended a number of common lectures, they had to develop and manage their own work space on the e-learning platform. Confidentiality was a must to each team (students from other teams could not have access to the work space of other teams). In this way, the learner had to ensure the roles of both the student and the teacher. One could remark that the teachers witnessed a somewhat surprising process of self-organization of work by the students involved in fulfilling their tasks.

Some opportunities to analyze the results and subsequently the efficiency of using the Moodle platform have been used:

- By comparing the grades obtained at the same subject matter by the students who had accessed the platform and the other students who had not used the platform;
- By comparing the results obtained by the students of the same group and taking into consideration the number of accesses of the platform: one noticed that the students who had significantly used the platform obtained higher scores;
- By analyzing the discussions and evolution of discussions developed on the forum (topics covered, number of interventions etc.).

As mentioned above, there are still many problems that could be tackled and solved in the use of the Moodle platform in our technical university and some of them will be approached in the future in order to extend the use of the Moodle platform in the educational process at the technical university.

5. Conclusions

The developments in the field of information technology urged the researchers to use the opportunities identified in this field, in order to improve the educational process. Hence many e-learning platforms have been proposed and used. Nowadays, due to some specific advantages, the most used e-learning platform is that proposed by Martin Dougiamas, namely Modular Object-Oriented Dynamic Learning Environment (Moodle). The platform has been constantly completed and improved by the contributions of the specialists using it. In order to better understand and use the Moodle platform in a technical university, an analysis of the Moodle platform structure use by means of some principles specific to the axiomatic design was developed. Even if initially the problems seemed to be simple, the detailed analysis revealed interesting aspects. Although many functional requirements could be identified in the case of designing the Moodle platform, only five functional requirements of first order were taken into consideration and adequate design parameters were thus proposed. It is an uncoupled design matrix that could correspond to the current use of the Moodle platform in the technical university under consideration. The investigation showed that relatively few opportunities offered by the Moodle platform were addressed up to now, being thus a real need to organize activities to better inform the teachers and students on the possibilities to expand the use of the Moodle platform. One may also consider that the use of axiomatic design principles in the analysis of the e-learning platform by teachers and students could help towards a better use of the platform by its beneficiaries. Since one estimates that the efficiency of using the Moodle platform in the educational process can be significantly improved, further investigations concerning the application of axiomatic design principles in order to extend the use of the Moodle platform in case of technical universities will be developed in the future.

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